

1. A transport unit for moving a microelectronic workpiece, comprising:  
a housing having a guide member configured to move linearly along a linear track;  
a vertical member extending from said housing, said vertical member being carried  
by said housing to move along a vertical path;  
an arm member extending from said vertical member, the arm member being carried  
by the vertical member to rotate about a first vertical axis, and the arm  
member having an end effector disposed for holding a workpiece and a first  
rotary actuator connected to said end effector for rotating said end effector  
about a horizontal axis.

2. The transport unit according to claim 1, further comprising a second  
rotary actuator connected to said vertical member for rotating said vertical member and said  
arm member about the first vertical axis.

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~~3.~~ 3. (Amended) The transport unit according to claim 2, wherein said arm  
member includes a first section and a second section, said first section carried by said  
vertical member at a first end thereof, and said first section rotationally carrying said second  
section at a second end thereof, said second section carrying said end effector, and wherein  
said transport unit further includes a third rotary actuator connected to said first and second  
sections for rotating said second section with respect to said first section about a second  
vertical axis.

4. The transport unit according to claim 1 further comprising a lift  
actuator carried by said housing and connected to said vertical member to vertically move  
said vertical member with respect to said housing.

5. The transport unit according to claim 1 wherein said housing comprises  
a linear bearing configured to be coupled to a rail of an external guide system and an  
electromagnet for transporting said transport unit along the rail.

6. The transport unit according to claim 1, wherein said end effector includes a horizontally extending member having at least one protruding member arranged for pressing an edge of a workpiece overlying said horizontally extending member, and a movable member, selectively movable to press the edge of the workpiece against the protruding member to grip said workpiece on said horizontally extending member.

7. The transport unit according to claim 6, wherein said horizontally extending member comprises a Y-shaped paddle and said at least one protruding body comprises two pins, each pin extending perpendicularly from one leg of said Y-shaped paddle.

8. The transport unit according to claim 6, wherein said movable member comprises a plunger arranged to press the edge of the workpiece, said plunger having a angled surface pressing said edge of said workpiece.

9. The transport unit according to claim 6 wherein said at least one protruding member comprises two spaced apart pins, and wherein said pins include radially extending flanges at end of said pins spaced from said horizontally extending member.

10. The transport unit according to claim 9 wherein said pins include an intermediate base portion having a surface which tapers toward a receiving surface of said horizontally extending member which is closest to said workpiece, such that said workpiece is supported on an edge thereof having its bottom surface spaced from a top surface of said receiving surface.

11. The transport unit according to claim 1, further comprising a workpiece presence sensor mounted to said effector, the sensor generating a signal corresponding to the presence of a workpiece on the effector.

12. The transport unit according to claim 11, wherein said effector comprises first and second upstanding portions which are arranged to press spaced apart locations on the edge of the workpiece to grip said workpiece between said first and second portions, one of said first and second portions being selectively movable to engage or disengage the workpiece from the effector.

13. The transport unit according to claim 12, wherein said first and second portions include retaining portions which overlie of the workpiece opposite a supporting surface of said end effector.

14. The transport unit according to claim 1, wherein said arm member includes:

a first section extending from said vertical member;  
a second section extending from said first section, said second section rotationally connected to said first section, said second section carrying said first rotary actuator and said end effector; and  
a second rotary actuator having a first portion connected to said first section and a second portion connected to said second section, and a rotary power source for rotating said first portion with respect to said second portion.

15. A system for moving workpieces, comprising:

a track assembly having first guide rail supported in a horizontal position;  
a transport unit including a housing supported by said rail and guided for sliding movement along said rail, a vertical member extending from said housing, and an arm member extending from said vertical member, said arm member having an end effector for holding a workpiece, and a first rotary actuator connected to said end effector for rotating said end effector about a horizontal axis; and

a linear actuating system coupled to the track and the housing for moving the housing linearly along the track.

16. The system according to claim 15, wherein said transport unit further comprises a second rotary actuator connected to said vertical member for rotating said vertical member and said arm member about a first vertical axis.

17. The system according to claim 15, wherein said arm member includes a first section and a second section, said first section carried by said vertical member at a first end thereof, and said first section rotationally carrying said second section at a second end thereof, said second section carrying said end effector, and said transport unit further including a third rotary actuator connected to said first and second sections for rotating said second section with respect to said first section about a second vertical axis.

18. The system according to claim 15, wherein said transport unit further comprises a lift actuator carried by said housing and connected to said vertical member to vertically move said vertical member with respect to said housing.

19. The system according to claim 15, wherein said housing comprises at least one linear bearing for receiving said rail.

20. The system according to claim 15, wherein said linear actuating system comprises an electromagnet for transporting said transport unit along said rail.

21. (Cancelled)

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26 (Cancelled)

27 (Cancelled)

28 (Cancelled)

29 (Cancelled)

30. (Cancelled)

31. A transport unit for manipulating a microelectronic workpiece, comprising:

a base having a guide member configured to move along an elongated track;

a linear actuator and an upright member carried by the base, wherein the linear actuator is coupled the upright member to move the upright member along an elevation axis;

an arm member carried by the upright member, the arm member extending at an angle relative to the elevational axis;

an end-effector coupled to the arm member, the end-effector being configured to releasably hold a microelectronic workpiece;

a first rotational actuator operatively coupled to the end-effector to rotate the end-effector about a flip axis in a manner that moves the workpiece between a face-up position and a face-down position; and

a second rotational actuator operatively coupled to at least one of the upright member and/or the arm member to rotate the arm member about the elevation axis.

32. The transport unit of claim 31, wherein the end-effector comprises an edge grip end-effector having a plurality of raised areas, an opening at each raised area, and a conduit for connecting each opening to a vacuum source, and wherein the raised areas are arranged on the end-effector in a circular pattern to contact a peripheral portion of the workpiece.

33. The transport unit of claim 32, wherein the circular pattern has a diameter of approximately 200mm to 300mm.

34. The transport unit of claim 31, wherein the base comprises a housing, the upright member comprises a vertical member, and the arm member comprises a first arm section coupled to the vertical member and a second arm section coupled to the first arm section.

35. A transport unit for handling a microelectronic workpiece, comprising:  
a support structure having a guide member configured to be slidably attached to an elongated track;  
a shaft member carried by the support structure at an angle to the elongated track, wherein the shaft member is coupled to a linear actuator to move the shaft member along a linear elevation path relative to the elongated track;  
an arm member carried by the shaft member, the arm member projecting from the shaft member;  
an edge-grip end-effector coupled to the arm member, the end-effector being configured to releasably engage only a peripheral portion of the microelectronic workpiece;  
a first rotational actuator operatively coupled to the end-effector to rotate the end-effector about a generally horizontal axis in a manner that moves the workpiece between a face-up position and a face-down position; and

a second rotational actuator operatively coupled to at least one of the shaft member and/or the arm member to rotate the arm member about a first axis that is generally in the direction of the elevation path.

36. The transport unit of claim 35, wherein the end-effector comprises a paddle having pins arranged in a circular pattern to contact an edge portion of the workpiece, and wherein the pins have a top flange and an inclined lower portion that define a groove to receive the edge portion of the workpiece.

37. The transport unit of claim 35, wherein the end-effector comprises a paddle having a plurality of raised areas, an opening at each raised area, and a conduit for connecting each opening to a vacuum source, and wherein the raised areas are arranged on the end-effector in a circular pattern to contact a peripheral portion of the workpiece.

38. The transport unit of claim 37, wherein the circular pattern has a diameter of approximately 200mm to 300mm.

39. The transport unit of claim 35, wherein the support structure comprises a housing, the shaft member comprises a vertical member, and the arm member comprises a first arm section coupled to the vertical member and a second arm section coupled to the first arm section.

40. A transport system for transporting a microelectronic workpiece between processing stations, the transport system comprising:

a linear track having a first guide rail on a first side of the track; and

a first transport unit including a first base having a first guide member slidably attached to the first rail, a first upright member carried by the first base to move along a first elevation path at an angle relative to the track, a first arm member carried by the first upright member, and a first edge-grip end-effector

carried by the first arm member, wherein the first upright member is linearly moveable along the first elevation path, the first arm member is rotatable about a first elevation axis generally normal to the first arm member, and the end-effector is rotatable about a first flip axis generally normal to the first elevation axis.

41. The transport system of claim 40, wherein the first end-effector comprises a first edge grip end-effector configured to contact a peripheral portion of the workpiece.

42. The transport system of claim 40, wherein the first end-effector comprises a first edge grip end-effector having a plurality of raised areas, an opening at each raised area, and a conduit for connecting each opening to a vacuum source, and wherein the raised areas are arranged on the first end-effector in a circular pattern to contact a peripheral portion of the workpiece.

43. The transport system of claim 42, wherein the circular pattern has a diameter of approximately 200mm to 300mm.

44. The transport system of claim 40, wherein the first base comprises a housing, the first upright member comprises a first vertical member, and the first arm member comprises a first arm section coupled to the first vertical member and a second arm section coupled to the first arm section.

45. The transport system of claim 40, further comprising an electromagnetic linear actuator coupled to the linear track and the first base of the first transport unit, the electromagnetic linear actuator having a plurality of permanent magnets arranged in a line along the track and an electromagnet attached to the first base.

46 (Cancelled)

47 (Cancelled)

48 (Cancelled)

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50. (Cancelled)

51. (Cancelled)

52. (Cancelled)

53. (Cancelled)